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ABSTRACT

Preschoolers' ability to utilize language in spatial problem solving was tested with 64 predominately middle-class children. The number of correct responses was analyzed using an age/sex/medium analysis of variance. It was found that the verbal response mode leads to substantially more correct responses than do pictures and that girls performed significantly better than boys. There were no significant differences between age levels (3.0-3.11 and 4.0-4.11), and there were no significant interactions between main effects. In general, the mental operations used in problem solving do not appear to be determined by the surface characteristics of the task (visual-spatial or verbal), but rather by the degree to which more linguistic-like descriptions or more visual-spatial and analog descriptions are required. The results imply that linguistic processes are accessible for problem solving at an early age and question the notion that the use of a visual mode precedes a verbal mode. (SW)

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Preschool Children's Ability to Coordinate Spatial Perspectives Through Linguistic Descriptions[1]

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[1]Footnote to cover sheet:

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Bruner (1966) has argued that the child proceeds in a fixed developmental sequence from reliance on a stimulus-bound visual mode of representation in problem solving during the iconic stage which dominates preschool years to an ability to use a more symbolic, verbal mode of representation beginning around the onset of schooling. Other theorists (e.g., Flavell, 1970; Kendler, 1972; Luria, 1957) have also argued that preschool children do not effectively use verbal strategies in cognitive tasks even though they have become skillful in their use of language for communication. Such arguments suggest that certain forms of information processing may be unavailable to young children.

However, as Blank (1974) has suggested, experimental paradigms generally used with preschoolers are most likely based on visual-spatial cues such as in paired-associates memory tasks (Jones, 1973) or serial position recall tasks (Brown, 1977). These tasks are thus unsuited for tapping the linguistic skills available to the young child. It may in fact be that the degree to which a more linguistic or a more visual-spatial mode is utilized in problem solving depends on the requirements of the task (e.g., Flowers & Dutch, 1976; Ives, in press; Palef & Olson, 1975; Tversky, 1973; Wells, 1972) and the symbolic response made imposed by the experimenter (Ives, in press).

For example, Ives (in press) found that children in Kindergarten, Grades 2, and 4 generally solved spatial perspective problems such as Piaget and Inhelder's (1956) three mountain task through linguistic descriptions and that a verbal response mode resulted in more correct responses than a pictorial response mode. In other words, an elementary school child was more likely to correctly verbalize another's view of an object (i.e., "the front of the car") than select a picture which indicates the other's view since the linguistic categories more clearly define the alternatives relevant to the task. Moreover, the item difficulty was found to be a function of the complexity of the linguistic description and was independent of the angle of separation between the child's and the observer's perspective. If indeed preschool children are also capable of using linguistic descriptions in problem solving, then a verbal response mode should facilitate more correct responses on a similar spatial perspective task. In order to test preschooler's ability to utilize language in spatial problem solving, the following experiment was devised.

Experimental Procedures

Participants

Sixty four predominately middle-class children, with equal numbers of boys and girls in two age groups

independently and each child received three of the six orientations for each of the four referents in a counter-balanced manner for a total of twelve responses per child.

Results and Discussion

The number of correct responses was analyzed using an Age (2) x Sex (2) x Medium(2) analysis of variance. It was found that the verbal response mode leads to substantially more correct responses (91% vs. 44%), $F(1,56)=53.06$, $p < .001$. Girls are significantly better than boys (75% vs. 60%), $F(1,56)=5.78$, $p < .02$, but there are no significant differences between age levels nor were there any significant interactions between main effects. A breakdown of the results can be seen in Table One.

The results thus imply that linguistic processes are accessible for problem solving at an early age and question the notion that the use of a visual mode precedes a verbal mode. Previous studies suggest that at age three years children generally begin to understand the terms front, back, and side (see Harris & Strommen, in press) but the high accuracy rate of the children in the present study invites further work with younger children to determine the relationship between the onset of the ability to use such reference terms and the onset

of perspective taking abilities. Since children as young as 18 months have been shown to have some ability to coordinate the reversal of perspectives (Benson & Bogartz, Note 1), this type of task provides an avenue to study the interrelationship between the development of problem solving abilities and the means to represent solutions.

The present results demonstrate that when given an appropriate mode of response three year olds have little difficulty indicating another's spatial perspective (90% correct). These findings are thus consistent with the position of Olson (1970) and others (e.g., Gardner, in press; Golomb, 1973; Ives, in press) that each means of symbolic representation has its own unique characteristics; response in any single medium cannot be viewed as an exact print-out of children's mental processes or necessarily an indication of the full extent of their competence. Spatial egocentrism in preschoolers emerges as a function of one particular mode of response (the pictorial) rather than, as Piaget and Inhelder (1956) claim, a general characteristic of preoperational thought. Analogously, development in spatial perspective taking seems better described as a process of correctly labelling another's view rather than as a simple presence or absence of spatial egocentrism.

In this context, the findings of girls' superiority in this task is not surprising given the previous find-

ings of their superiority on verbal tasks (Maccoby & Jacklin, 1974). The fact that girls are superior in the picture selection condition as well as in the verbal condition indicates that perhaps linguistic processing underlies correct solutions in both conditions. Observation of children of both sexes in the picture selection condition suggests that successful children first formulate the label of the correct response, often spontaneously verbalizing it, and then search for the appropriate picture rather than directly comparing the pictures to the array to determine the correct response. The latter strategy is more likely to lead to egocentric responses.

The sex differences are consistent with Bryden's (Note2) findings that women are more likely to use linguistic strategies in spatial problem solving and Karnovsky's (Note 3) finding that the use of familiar objects rather than abstract figures in spatial rotation tasks has a greater facilitating effect of girl's than boy's performance. Like the referent objects in the present experiment Karnovsky's familiar objects contained inherent features such as front and back whereas the abstract figures did not. Sex differences in spatial tasks should not be simply attributed to general sex differences in spatial ability but rather to the types of spatial strategies made available by the requirements of the tasks.

In general, the mental operations used in problem solving do not appear to be determined by the surface characteristics of the task (that is, whether it is couched in a visual-spatial or verbal form), but rather by the degree to which more linguistic-like descriptions or more visual-spatial and analog descriptions are called for. Preschoolers are quite capable of using linguistic descriptions when the task is appropriate and the experimenter or teacher provides the opportunity for verbal response. If these speculations are correct, then one task of the educator is to move beyond the traditional spatial-verbal dichotomy, determine the skills actually necessary to solve particular tasks, and devise training strategies to fit the nature of the task and the preference and skills of the individual.

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Table 1

Mean Percent of Responses by Type

Age	Response Mode	Sex	Correct Response	Egocentric Error	Non-Egocentric Error
3.0-3.11	Pictures	Male	27	63	10
		Female	49	46	07
		Total	37	54	09
	Verbal	Male	86	07	06
		Female	93	05	02
		Total	90	06	04
4.0-4.11	Pictures	Male	42	48	10
		Female	60	30	09
		Total	51	39	10
	Verbal	Male	85	13	02
		Female	100	00	00
		Total	93	06	01